MAY 15.

REV. H. C. McCOOK, D. D., Vice-President, in the chair.

Eighteen persons present.

The deaths were announced of Caleb Cope, a member, on the 12th, inst. and Dr. Gerhard Vom Rath, a correspondent, April 23.

A paper entitled "Notes on new species of Orb-weaving Spiders." By Rev. Henry C. McCook was presented for publication.

Notes on the Relations of Structure and Function to Color Changes in Spiders.—Rev. Dr. HENRY C. McCOOK submitted the following remarks on color changes in spiders, which he wished to be understood as in part, at least, tentative. They were intended to evoke suggestions and helpful information from members of the Academy and others, rather than to present final conclusions on a most interesting subject.

I. On the Relation of Structure to Color he observed that:—

1 The color of young spiders is almost without exception light yellow, or green, whitish or livid, tints that blend very well with the prevailing greens of foliage, young twigs and the grays of bark of trees, of rocks and soil. This is due largely to the fact that the tissues are at that time translucent, allowing a free play of light through them. The effect is also, probably, caused by the absence of food in the alimentary tract and lack of distribution of nutriment throughout the system.

As young spiders advance in age the color deepens, which is caused no doubt by gradual hardening of the tissues, thus making them more opaque. Up to this period no food has been taken, hence the absence of food alone is not sufficient to account for the light colors of the first stages after exode. Yellows and browns in various tints occur at this period, and in some cases, not generally he believed, color patterns which are characteristic of the various species in adult life begin to appear with more or less distinctness, or at least suggestively. It is not until sedentary spiderlings have established themselves upon their own webs, and so to speak, have set up housekeeping for themselves, that the characteristic colors of the species begin to appear with any positive degree of distinctness.

2 As the spiders further advance in age and make their successive moults, various color changes may be noted. Immediately after moulting the color is always lighter, which is probably due to the fact that the harder skin, just cast off, prevented the passage of light through the tissues. The new skin is probably thinner, and more translucent. Dr. McCook believed that moulting produces changes in color patterns of a very decided kind, at least in certain species. Apparently some organic change occurs which is the cause of this phenomenon.

3 In old age the color changes are very decided in almost all species. In some, as *Eperia trifolium* and *Epeira thaddeus*, the changes give added brilliancy to the color at certain parts of the body. Some of the color changes of *trifolium* are very beautiful and the same is true of *thaddeus*.

But advanced age, as a rule, makes the colors darker. Orange and brown then have a ruddier hue; yellows darken into orange and brown. Sometimes the yellow patterns are entirely lost, and the spider becomes very dark, almost black. There is a grizzled appearance about the animal in this stage which reminds one of the corresponding condition of man and lower vertebrate animals. These last named changes are manifest in the spider after the final deposit of eggs.

4 In gravid females the changes of color are often very decided. Some of the bright colors upon *trifolium* and *thaddeus* are doubtless due to this condition. Most spiders during gestation have a lighter color, which may be the result of mechanical changes in structure. The skin becomes distended and more transparent, the pigment is thereby distributed, and thus centres of color are broken up and the color matter diffused. Not only the skin, but other parts of the abdomen are distended during gestation, and this distension produces changes in the color of the animal by modifying in some way the various secretions from the liver and other organs.

5 The little pits or dark spots upon the dorsum of the abdomen which mark the attachment of the muscles within, appeared to him to be centres for aggregation of coloring material. At least the dorsal patterns seem to be grouped in some regular way around these muscular attachments. Thus the action of the muscles on the skin and chitinous shell or walls serves to compel certain aggregations along the lines of use, that form these colors and patterns. It might be important in this connection to consider what is the ordinary effect of muscular action upon the distribution of pigment in the human system or with vertebrate animals?*

The color rings or annuli around the joints of the limbs of spiders may also be produced by action of the muscles. It is noticeable that the tendency of these darker and more vivid colors is towards the ends of the joints, as though by the outward action of the muscles the pigment were forced mechanically or otherwise attracted toward these points.

In the cephalthorax may be noted the same tendency of color to group itself around the points of muscular attachment, particularly

* After the remarks here recorded, Dr. Nolan, the Secretary, called attention to the fact that he then had in hand for publication a paper by Dr. Harrison Allen, on "The Distribution of the Color Marks of the Mammalia." This paper has now appeared, and is a most valuable and interesting one. (See Proceed. Acad. Nat. Sci. Phila., 1888, pp. 85–105). The following sentence is quoted therefrom as bearing upon the above suggestion: "The stripes and spots on the limbs and the dapple-marks on the trunk, as well as some of the broader sheets of color, appear to be related to the intervals between the muscle-masses or to the extent of skin surfaces which correspond to muscles." p. 100.

the central depression. Dr. McCook added that, as far as he knew, no araneologist had suggested the theory of muscular attachment and action as effecting color distribution, and he did not wish his opinion for the present to be considered as fixed; but he thought the theory probable, at least.

II. On the Relation of Environment and Habit to Color Changes, it was observed:

1 Spiders that live upon plants as a rule have colors that are harmonious with the prevailing greens and yellows, and admixtures thereof, of branches, leaves and flowers.

2 Spiders that nest in stables, houses, on fences etc., ordinarily have dusky colors, harmonious with the environment. Examples, *Theridion vulgare, Agalena nævia, Tegenaria medicinalis* (*Durhami*) etc. However, the speaker did not find that any great difference in color is observable in the above species when they are found nesting in foliage, as is often the case, at least with *Agalena* and *Theridion*. It might be said, perhaps, that there is a slight tendency to darker and a more uniform color when the spiders are found in the first named locations.

3 Ground spiders (the Lycosids etc.) generally have colors of neutral grays that blend well either with the soil, with rocks or with stalks of grass etc., especially when the latter are somewhat dry.* Lycosids found in the neighborhood of streams do not seem to be especially influenced by the natural color of water; but *Dolomedes sexpunctatus*, which is so constantly found on the water, frequently has a tint like that of the stream itself.

4 Saltigrades follow the rule of the Lycosids as to color. Their colors harmonize well with the surface of rocks, trunks of trees etc., upon which they habitually seek their prey. They are also sufficiently harmonized with the color of leaves and the ground.

The metallic green on the fangs of some Saltigrades seems almost like a green leaf-ambush to the body of the creature as it is observed stalking its prey. This suggests the strategy most familiar from its association with the lines of Shakespeare:

> "Macbeth shall never vanquished be, until
> Great Birnamwood to the Dunsinane hill
> Shall come against him."

Of course this suggestion is fanciful; but of what use to the creature can such a provision be if it serves not as an aid in securing its prey or protecting it against enemies? One might almost be justified for asking: can there possibly be anything in the above idea?

5 Are the brightest colored spiders, which one would suppose naturally to be most exposed to enemies like birds, and raiding ichneumon-flies and mud-dauber wasps, commonly protected by their industry? Dr. McCook cited a few examples as bearing upon this

* It is a fact that the darker colors of most spiders are found contemporaneously with the autumn changes of the foliage to a duskier hue, but the two facts are probably due to the same cause, viz., the advancement of decay and the changes which result from this last named stage of vitality.

inquiry. *Argiope riparia* and *fasciata* have protective wings of retitelarian lines thrown out on each side of their nets, which protect the exterior of their bodies; and a thick shield-like sheeting which protects the underside of the body. These spiders are highly colored and conspicuous by size; they dwell in shrubs, bushes, grasses, low trees, and commonly are stationed in the centre of their round webs, having no domicile or tent to which they retire.

The very bright colored spiders *Epeira insularis* and *trifolium*, do not hang habitually in the centre of their webs, but live in leafy tents and their habitat is among shrubs and trees. *Insularis* inclines to groves etc., much more strongly than *trifolium*. *Epeira thaddeus* has the same habit.

Per contra, *Eperia strix*, which is not a bright colored spider, by any means, is one of the most secretive orb-weavers in its habits, dwelling in a domicile of rolled leaves, shrinking away into cavities and holes, under bark etc., and only occupying its snare during the night.

Epeira domiciliorum and *cinerea* (*Harrisonæ*) are also spiders of rather inconspicuous colors, and both of them screen themselves in tents, though *domiciliorum*, at least, not so habitually as *insularis* and *trifolium*.

Epeira labyrinthea and *triaranea* are among the most strongly protected by industry, having besides their orb and thick retitelarian snare, a dome-shaped silken tent as a domicile, and *labryinthea* in addition a dry leaf as shelter above her body or tent. These spiders are strongly marked as to their patterns but do not have the bright hues which characterize *Argiope, Epeira insularis* and others.

Meta hortorum is one of the most brilliantly colored of our indiginous spiders. Although its colors harmonize, particularly its green and metallic silver, with its leafy surroundings, it rests beneath its horizontal orb, and has straggling, pyramidal, retitelarian lines beneath it. It dwells mostly in wooded places, at least in this neighborhood. *Epeira gibberosa* is also a bright colored spider. It dwells beneath a sort of hammock or stretcher of lines woven between the edges of a leaf. It is thus very well protected.

Our three indiginous species of *Acrosoma*, *rugosa*, *spinea* and *mitrata* are all, particularly the first two, well marked spiders. They are protected, *mitrata* least conspicuously, by spinous processes, (if such can be called protections). They live in the centre of their orbs as a rule, and their webs are most frequently found stretched between the trunks of young trees, in openings of groves, woods, and like spots.

Gasteracantha, with its strongly developed spines has very much the same habit as our indiginous *Acrosoma*, but the spines appear to be wanting in the young of this genus, the very age, one would think, at which they are most needed. However, the young of *Gasteracantha*, at least with numerous specimens sent from the Pa-

cific coast, are almost black in color, a feature which may certainly be regarded as protective if bright colors best invite the observation of enemies.

On the whole, the conclusion seems justified that many spiders that appear to be more exposed to enemies by reason of bright colors or greater size, have developed, or at least possess, special variations in industry and habits that in some degree are protective. But there are a number of apparent exceptions which require more careful study before any general deduction can be warranted.

MAY 22.

Mr. J. H. REDFIELD, in the chair.

Twenty-one persons present.

MAY 29.

Mr. J. H. REDFIELD, in the chair.

Eleven persons present.

The following papers were presented for publication:

"Description of a new species of Etheostoma (*E. longimana*)." By David Starr Jordan.

"On the generic name of the Tunny." By David Starr Jordan.

JUNE 5.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-four persons present.

On an Insect-Larva Habitation.—A communication was read from Miss Adele M. Fielde stating that during June of last year there were found near her house at Swatow, China, two specimens of an insect larva-habitation, of a sort that she had not seen there before, during a residence of a dozen years. The one was attached to an exotic oak-leaved geranium, the other was crawling upon a path under a *Pinus sinensis*. The first, some days later, gave issue to a small brown moth. She opened the second and found the occupant to be three-fourths of an inch in length, and black, with white specks on the head and thorax. It had three pairs of short legs, ten abdominal segments, and biting mouth-parts. Its house was builded from small dry stalks of plants, cut evenly and laid side by side in a spiral of expanding whorls, the larger coils overlapping the smaller at the lower edge, showing the lower ends of the straws. The colors